

1 CLAIMS:

2 1. A chemical-mechanical polishing (CMP) method comprising:
3 applying a solid abrasive material to a substrate;
4 polishing the substrate with the abrasive material;
5 flocculating at least a portion of the abrasive material on the
6 substrate; and
7 removing at least a majority portion of the flocculated portion of
8 the abrasive material from the substrate.

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10 2. The CMP method of claim 1, wherein applying a solid
11 abrasive material comprises applying a CMP slurry comprising
12 substantially dispersed, solid abrasive material to the substrate and
13 polishing the substrate comprises polishing the substrate with the slurry.

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15 3. The CMP method of claim 1, wherein applying a solid
16 abrasive material comprises applying a polishing pad comprising solid
17 abrasive material to the substrate and polishing the substrate comprises
18 polishing the substrate with the pad.

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20 4. The CMP method of claim 1, wherein the abrasive material
21 comprises ceria.
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1 5. The CMP method of claim 1, wherein a temperature of the
2 substrate during the flocculating does not exceed about 40 degrees
3 Celsius (°C).

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5 6. The CMP method of claim 1, wherein the flocculating occurs
6 after the polishing.

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8 7. The CMP method of claim 6, wherein the flocculating is
9 performed on a secondary platen of a CMP tool.

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11 8. The CMP method of claim 6, wherein the flocculating is
12 performed during spray action within a CMP tool.

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14 9. The CMP method of claim 6, wherein the flocculating is
15 performed during immersion in an aqueous bath.

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17 10. The CMP method of claim 6, wherein the flocculating is
18 performed in conjunction with polyvinyl alcohol brush scrubbing of the
19 substrate.

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21 11. The CMP method of claim 6, wherein the flocculating is
22 performed prior to cleaning by high-pressure spray action.

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3 12. A CMP method comprising:
4 applying a solid abrasive material to a substrate;
5 polishing the substrate with the abrasive material;
6 applying a surfactant comprising material to the substrate and
7 flocculating at least a portion of the abrasive material with the surfactant
8 comprising material;
9 removing at least a majority portion of the flocculated portion of
10 the abrasive material from the substrate.
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12 13. The CMP method of claim 12, wherein applying a solid
13 abrasive material comprises applying a CMP slurry comprising
14 substantially dispersed, solid abrasive material to the substrate and
15 polishing the substrate comprises polishing the substrate with the slurry.
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17 14. The CMP method of claim 12, wherein applying a solid
18 abrasive material comprises applying a polishing pad comprising solid
19 abrasive material to the substrate and polishing the substrate comprises
20 polishing the substrate with the pad.
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15. The CMP method of claim 12, wherein the abrasive material comprises ceria.

16. The CMP method of claim 6, wherein a concentration of the surfactant in the surfactant comprising material comprises about 10 micrograms per milliliter ($\mu\text{g/ml}$) to about 10,000 $\mu\text{g/ml}$.

17. The CMP method of claim 16, wherein the concentration comprises about 100 $\mu\text{g/ml}$ to about 1,000 $\mu\text{g/ml}$.

18. The CMP method of claim 12, wherein a temperature of the substrate during the flocculating does not exceed about 40 °C.

19. The CMP method of claim 12, wherein the surfactant comprising material is applied after the polishing.

20. The CMP method of claim 12, wherein the flocculating further comprises complexing at least a portion of the abrasive material with the surfactant.

21. The CMP method of claim 12, wherein the surfactant comprises a cationic surfactant.

1 22. The CMP method of claim 21, wherein the cationic
2 surfactant comprises a quaternary ammonium substituted salt.

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4 23. The CMP method of claim 22, wherein the quaternary
5 ammonium substituted salt comprises a quaternary ammonium halide.

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7 24. The CMP method of claim 23, wherein the quaternary
8 ammonium halide comprises a cetyltrimethylammonium bromide.

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10 25. The CMP method of claim 23, wherein the quaternary
11 ammonium halide comprises a polyethoxylated quaternary ammonium
12 halide.

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1 26. A CMP method comprising:
2 applying a CMP slurry comprising substantially dispersed, solid
3 abrasive material to a substrate;
4 polishing the substrate with the slurry;
5 applying to the substrate a surfactant comprising material that
6 exhibits the characteristic of decreasing a settling time for the abrasive
7 material in an aqueous dilution of the slurry;
8 removing at least a majority portion of the abrasive from the
9 substrate.

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11 27. The CMP method of claim 26, wherein the abrasive material
12 comprises ceria.

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14 28. The CMP method of claim 26, wherein a temperature of the
15 aqueous dilution does not exceed about 40 °C.

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17 29. The CMP method of claim 26, wherein the surfactant
18 comprising material is applied after the polishing.

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20 30. The CMP method of claim 26, wherein complexing between
21 at least a portion of the abrasive material and the surfactant forms
22 flocule.
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3 32. A CMP method comprising:
4 applying a CMP slurry comprising substantially dispersed, solid
5 abrasive material to a substrate;
6 polishing the substrate with the slurry;
7 applying to the substrate a surfactant comprising material, wherein
8 the surfactant exhibits a one-hour settling rate constant of greater than
9 0.035 for the abrasive material in an aqueous mixture of about 0.1
10 weight percent surfactant and about 1 weight percent slurry;
11 removing at least a majority portion of the abrasive material from
12 the substrate.
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14 33. The CMP method of claim 32, wherein the abrasive material
15 comprises ceria.
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17 34. The CMP method of claim 32, wherein a temperature of the
18 aqueous mixture does not exceed about 40 °C.
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20 35. The CMP method of claim 32, wherein the settling rate
21 constant is greater than about 0.09.
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1 36. The CMP method of claim 32, wherein the surfactant
2 comprising material is applied after the polishing.

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4 37. The CMP method of claim 32, wherein complexing between
5 at least a portion of the abrasive material and the surfactant forms
6 floccule.

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8 38. The CMP method of claim 32, wherein the surfactant
9 comprises a cationic surfactant.
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1 39. A CMP method comprising:
2 applying a ceria-based solid abrasive material to a substrate;
3 polishing the substrate with the abrasive material;
4 applying a cationic surfactant comprising material to the substrate
5 and flocculating at least a portion of the abrasive material; and
6 removing at least a majority portion of the flocculated portion of
7 the abrasive material from the substrate.

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9 40. The CMP method of claim 39, wherein applying a solid
10 abrasive material comprises applying a CMP slurry comprising
11 substantially dispersed, solid abrasive material to the substrate and
12 polishing the substrate comprises polishing the substrate with the slurry.

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14 41. The CMP method of claim 39, wherein applying a solid
15 abrasive material comprises applying a polishing pad comprising solid
16 abrasive material to the substrate and polishing the substrate comprises
17 polishing the substrate with the pad.

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19 42. The CMP method of claim 39, wherein a concentration of
20 the cationic surfactant in the surfactant comprising material comprises
21 about 10 micrograms per milliliter ($\mu\text{g/ml}$) to about 10,000 $\mu\text{g/ml}$.

1 43. The CMP method of claim 42, wherein the concentration
2 comprises about 100 $\mu\text{g/ml}$ to about 1,000 $\mu\text{g/ml}$.

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4 44. The CMP method of claim 39, wherein a temperature of the
5 substrate during the flocculating does not exceed about 40 °C.

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7 45. The CMP method of claim 39, wherein the surfactant
8 comprising material is applied after the polishing.

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10 46. The CMP method of claim 39, wherein the flocculating
11 further comprises complexing at least a portion of the abrasive material
12 with the cationic surfactant.

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14 47. The CMP method of claim 39, wherein the cationic
15 surfactant comprises a quaternary ammonium substituted salt.

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48. A CMP method comprising:
 applying a solid abrasive material to a substrate;
 polishing the substrate with the abrasive material;
 after polishing, brush scrubbing the substrate using a scrubbing
 solution comprising a surfactant material to flocculate and remove at
 least a majority portion of the abrasive material.

49. The CMP method of claim 48, wherein applying a solid
 abrasive material comprises applying a CMP slurry comprising
 substantially dispersed, solid abrasive material to the substrate and
 polishing the substrate comprises polishing the substrate with the slurry.

50. The CMP method of claim 48, wherein applying a solid
 abrasive material comprises applying a polishing pad comprising solid
 abrasive material to the substrate and polishing the substrate comprises
 polishing the substrate with the pad.

51. The CMP method of claim 48, wherein the abrasive material
 comprises ceria.

52. The CMP method of claim 48, wherein a temperature of the
 substrate during the flocculating does not exceed about 40 °C.

1 53. The CMP method of claim 48, wherein the flocculating
2 further comprises complexing at least a portion of the abrasive material
3 with the surfactant material.

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5 54. The CMP method of claim 48, wherein the surfactant
6 material comprises a cationic surfactant.

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8 55. The CMP method of claim 54, wherein the cationic
9 surfactant comprises a quaternary ammonium substituted salt.

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1 56. A CMP method comprising:

2 applying a solid abrasive material to a substrate;

3 polishing the substrate with the abrasive material;

4 after polishing, pressure spraying the substrate using a spray
5 solution comprising a surfactant material to flocculate and remove at
6 least a majority portion of the abrasive material.

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8 57. The CMP method of claim 56, wherein applying a solid
9 abrasive material comprises applying a CMP slurry comprising
10 substantially dispersed, solid abrasive material to the substrate and
11 polishing the substrate comprises polishing the substrate with the slurry.

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13 58. The CMP method of claim 56, wherein applying a solid
14 abrasive material comprises applying a polishing pad comprising solid
15 abrasive material to the substrate and polishing the substrate comprises
16 polishing the substrate with the pad.

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18 59. The CMP method of claim 56, wherein the abrasive material
19 comprises ceria.

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21 60. The CMP method of claim 56, wherein a temperature of the
22 substrate during the flocculating does not exceed about 40 °C.

1 61. The CMP method of claim 56, wherein the flocculating
2 further comprises complexing at least a portion of the abrasive material
3 with the surfactant material.

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5 62. The CMP method of claim 56, wherein the surfactant
6 material comprises a cationic surfactant.

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8 63. The CMP method of claim 62, wherein the cationic
9 surfactant comprises a quaternary ammonium substituted salt.

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64. A CMP method comprising:

applying a solid abrasive material to a substrate;

primary polishing the substrate with the abrasive material;

buffing the substrate along with applying a surfactant comprising material to the substrate and flocculating at least a portion of the abrasive material with the surfactant comprising material; and

removing at least a majority portion of the flocculated portion of the abrasive material from the substrate.

65. The CMP method of claim 64, wherein applying a solid abrasive material comprises applying a CMP slurry comprising substantially dispersed, solid abrasive material to the substrate and polishing the substrate comprises polishing the substrate with the slurry.

66. The CMP method of claim 64, wherein applying a solid abrasive material comprises applying a polishing pad comprising solid abrasive material to the substrate and polishing the substrate comprises polishing the substrate with the pad.

67. The CMP method of claim 64, wherein the abrasive material comprises ceria.

1 68. The CMP method of claim 64, wherein a temperature of the
2 substrate during the flocculating does not exceed about 40 °C.

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4 69. The CMP method of claim 64, wherein the flocculating
5 further comprises complexing at least a portion of the abrasive material
6 with the surfactant comprising material.

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8 70. The CMP method of claim 64, wherein the surfactant
9 comprising material comprises a cationic surfactant.

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